~~RESTRICTED~~

ECONOMIC MOBILIZATION COURSE

1947 - 1948

RESEARCH AND DEVELOPMENT IN MEDICINE

Captain C. W. Shilling

8 December 1947

THE INDUSTRIAL COLLEGE OF THE ARMED FORCES
WASHINGTON, D.C.

~~RESTRICTED~~

RESEARCH AND DEVELOPMENT IN MEDICINE

8 December 1947

CONTENTS

Page

SPEAKER--Captain C.W. Shilling, MC, USN, Director, Medical Sciences Division, Office of Naval Research, Department of the Navy..... 1

Publication Number L48-56
THE INDUSTRIAL COLLEGE OF THE ARMED FORCES
WASHINGTON, D.C.

RESEARCH AND DEVELOPMENT IN MEDICINE

8 December 1947

CAPTAIN ROWLEY: We are going into the last week in which we will have technological lectures. This morning we are going to start the week off by hearing about research and development in medicine.

You may wonder why we picked a naval officer of the Medical Corps to give this lecture; but if you think a little bit you will realize that the Services are interested not only in all the research that the Public Health Service and other Federal and private agencies and institutions are doing, but a lot that we are doing ourselves.

Captain Shilling, of the Office of Naval Research, is in the business of furthering Navy contracts with outside medical laboratories in that field. He received his Doctor of Medicine degree from the University of Michigan in 1927. Since then he has had varied naval medical service of the standard variety, except that he has to a certain extent specialized in parts of his career in submarine medicine. I take great pleasure in introducing Captain Charles W. Shilling, of the Medical Corps.

CAPTAIN SHILLING: I feel honored to be with you here today. It is true that I have specialized in submarines to the extent that my last tour of duty consisted of eight years and nine months at the Submarine Base at New London awaiting change of orders. I was working there on Bureau of Navigation orders when I left there last year. So I have specialized in submarines for that period, but it has been in the field of research; and I think that if you know research as it is related to one particular field, you are quite likely to know something about it as it relates to other fields.

The most important single asset of any country, I would say, is its human resources. Nothing could be more important to the national security than to maintain this resource at its absolute peak of efficiency. The medical people are the ones at least traditionally supposed to maintain this efficiency and to accomplish this proposition of keeping it at its peak. Therefore it is logical to conclude that the importance of scientific and technological progress in medicine in maintaining national security is very great indeed.

I would like you to note that during this talk when I say "medical" I don't mean medical in the restricted sense of M.D.'s. I mean medical in the sense of all the biological sciences, including physiology and

psychology, in the sense of all groups that are working in these specialties like aviation medicine and so forth. I mean the PhD's as well as the M.D.'s when I use the word "medical".

The first question we want to ask ourselves, is, How do we maintain our human resources at their most efficient level? First, by the maintenance of health; because, if you keep the people well, you keep the human resources at their most efficient level.

How do you keep them well? First, by the prevention of the occurrence of disease. That carries with it not only the matter of handling the problems of public health, but educating the people involved in any particular area. Second, by improving the techniques of the treatment of diseases and surgical conditions. That includes not only the time-honored practice of medicine, but the practice of all the healing arts that are connected with the word "medicine." Third, by medical research in its broadest sense. Only by medical research can the first two be implemented and kept strong.

The second question is, How to maintain our human resources at their most efficient level by the proper utilization of the available manpower? Now, one doesn't usually think of that as within the practice of medicine in the restricted sense; but certainly the general problem of selecting the right man for the right job is partially the province of medicine, particularly when you think of it in its broad sense as defined earlier in this talk, comprising physical selection, psychometric selection, psychological selection, and psychiatric selection. We will discuss those later, but at least these are the main headings.

Training is very definitely a part of the problem of utilizing the available manpower; but I am not going to discuss training, because that does not come within the province of this field. But you must bear that in mind. You must realize that training is very definitely linked with the problem of selection and thus a problem of the medical man, particularly when we include psychology, which is very capable of helping in the field of training.

Let us discuss how we are going to maintain manpower at its peak of efficiency by the maintenance of health. I want to develop this by reviewing some of the history and giving some examples.

If you go back not too far to some of the older superstitious beliefs you will remember that demons were the cause of disease. That is believed in some parts of the world even today. Diseases were the punishment for wrong doing. Even today you find some of your friends,

when catastrophe befalls them, bemoaning, "Now, what did I do that was wrong? How have I offended God that he could be that angry?" We are not too far away from that in some of our thinking today. Astrology played a very important part in explaining the cause of disease.

When anything happened, of course, the treatment quite naturally and logically consisted of propitiation for one's sins by prayers, charms, and holy relics. Every disease had its god or goddess that had to be taken care of in case one wanted to be cured.

Witchcraft was practiced even in our own country. We all remember that in our history. Some of it——at least in the form of quackery——exists even today. You perhaps would not believe it, but within the last ten days I have had a man in the office, and about a month ago I had another individual in the office, trying to interest us in the old Abrams box. That was brought out about 1922. There must be one or two medicos in the audience, and you electrical engineers would be interested in it too. It is a very beautiful gadget. It has a lot of dials and all the other paraphernalia that go with an electrical device.

With that box, all you have to do is to be connected with it in some way——if you can't be there, you can send a sample of your blood on blotting paper——and out of that box will come the diagnosis of what you have. It has all possible diagnoses available, so it is a fairly simple proposition. By the way, those are sold by the thousands and are used by some of those borderline brethren working in the supposed healing arts. All you have to do in the way of treatment, of course, is this: You know, every disease, according to them, has a very definite normal electrical response. If you have a disease, the response is altered in a characteristic way. All you have to do to cure the disease is to superimpose the normal electrical response over that other and you are all set. That is very close to witchcraft, but that is going on all the time. People come to the Office of Naval Research for backing on that proposition. Two people have come already. So we don't want to think we are too far away from the old ideas.

Now I will give as examples two different diseases which have had tremendous military significance; so I am sure you are interested in them even though it may only be an historical interest. One is typhoid fever. That is an example of a disease that has been largely eradicated by preventative inoculations and by the improvement and enforcement of sanitary conditions and the enforcement of public health laws.

These two quotations will serve to highlight the typhoid problem. The first is from "Devils, Disease, and Doctors," by Haggard.

"Comparatively few years ago typhoid fever alone killed more men than die today from all the acutely infectious diseases put together." This was in our United States. "Formerly typhoid fever often reached the dimensions of a pestilence. It has always flourished in encampments during war. In each year of the Civil War of the United States 1000 out of every 100,000 died of typhoid, and this was not thought extraordinary. In the Spanish War (1898) the prevalence of typhoid was considered a disgrace, although only 100 men in every 100,000 died of it. In World War I five died of thphoid in every 100,000. This decrease in the prevalence of typhoid was due to preventive medicine and not to theology. The care of drinking water took the place of incantations. The sanitary disposal of excrement became a ritual. Prophylactic inoculation against the disease replaced the wearing of charms and holy relics. The screening out of flies was found more effective in preventing the spread of typhoid than all the prayers of the pious."

That shows how we can advance when we divorce our thinking from the early concepts of the causes of disease.

I think you might be particularly interested in the plague. You all remember the plague epidemic that started in Egypt in the lower Nile. That has been completely eradicated from Egypt. You remember the appeals that were responsible for the trainload after trainload of materials and supplies that stopped the advance of the plague. I would like to take you with me back to the year 542, when the plague started in the lower Nile, exactly as it did a few months back, in Alexandria. Again I would like to quote from Haggard's book:

"...plague broke out in lower Egypt. It spread slowly up the Nile and crept from there into Asia Minor. At first it followed the coast line, where the traffic was most active. Gradually it worked into the interior. It reached Constantinople. There at its height it killed 5 to 10 thousand persons daily. In its relentless advance the plague extended over Greece and into Italy; it entered Gaul and reached to the Rhine. This spread of the plague took fifteen years. Then it slowly receded and on its return struck again at Constantinople. It had lost none of its virulence from its travels. The piled-up dead of Constantinople were disposed of by unroofing the towers of the walls, cramming the space thus exposed with corpses, and replacing the roof.

"As if replete from its harvest of the sixth century, the plague except for minor outbreaks, lay dormant for 800 years. Plague was epidemic again in 1348. In that year Clement VI granted absolution from all sins of all Christians who should die on a journey to Rome, where, in spite of the plague, a Holy Year was being celebrated. Not only was absolution given, but the souls of those who died were to be carried straight to heaven without first passing through purgatory. By Easter 1,200,000 people from all parts of Europe had

gathered at Rome. Some of these pilgrims brought the plague with them; it spread rapidly through the crowded people. Scarcely 10 percent lived to return to their homes." (In other words, he is saying that 1,080,000 of that 1,200,000 died of the plague within that few-weeks period.)

"During the fourteenth century, in Europe alone, 25 million persons perished, and all in all about one-fourth of the entire population was swept off by recurrent epidemics of the plague before it subsided."

I won't take time to go into the superstitions connected with these outbreaks; but, of course, they tried to pin the spread of plague on various unpopular groups. In one area alone twelve thousand Jews were killed in one town because they were supposed to have spread the plague. The torture that went on in trying to find out who had spread it in other places is unbelievable. The whole situation was one that is just awful. And yet that plague, if it had not been for the medical advances, could spread right through Europe in the same way. People perhaps are not aware that the plague reached our shores once within the lifetime of this group sitting here. It was covered up very carefully and eradicated within a few days after the first cases were discovered. The army of public health workers that jumped on that situation is the organization that we have in this country that will protect us from this sort of thing.

I won't take time to go into the history of the smallpox epidemic. I think we had in the total Armed Forces something like five or six cases of smallpox during the late war. How they got by the Naval officers I can't understand, because usually a person was vaccinated at least ten times before it got into the records. But that is not an amazing situation when you realize how many men were scattered throughout the world.

Macaulay, the English historian, gives an interesting paragraph that I would like to quote to give you an idea what smallpox used to be like. I imagine that there is no one here who has seen a case of smallpox. They are pretty rare nowadays. You don't see them any more. Macaulay says:

"That disease, over which science has since achieved a succession of glorious and beneficial victories, was the most terrible of all the ministers of death. The havoc of the plague had been far more rapid, but plague has reached our shores only once or twice within living memory; and smallpox was always present, filling the churchyard with corpses, tormenting with constant fear all whom it had not yet stricken, leaving on those whose lives it spared the hideous traces of its powers, turning the babe into a changeling at which the mother shuddered, making the eyes and cheeks of the betrothed maiden objects of horror to the lover."

If you like your picture of the situation in a less poetic and more practical form, consider for a moment the situation in Boston not too many years back, in the eighteenth century, along in 1798, to be exact. At that time there were 18,000 people living in Boston. Of that group 10,000 had previously had smallpox and were immune. In the epidemic of 1792 the remaining 8,000 got smallpox. You can't get any simpler statistics than those. If you hadn't had it, you got it.

The death rate from smallpox was very, very high. As a matter of fact, it has been reliably estimated by a number of people working at it from various angles that in the eighteenth century—and the eighteenth century is not so long ago—in that century alone 60 million people died of smallpox in Europe, or 600,000 deaths a year from this one disease.

It can be positively prevented and simply prevented without danger to anyone. The military services, of course, have an enviable record. We just don't have it. But, unfortunately, it is not so good in the country as a whole, because most of the civilians are vaccinated only once. They forget about it afterward. You remember the scare in New York City last year, with two deaths. That could have been worse but tens of thousands hastened to be vaccinated.

Instead of stories about these three diseases let us turn to the war statistics, which, I think are particularly interesting to this group. They are of particular interest to anyone who studies the progress of medical achievements or any other achievements, because they give you a mass of statistics which highlight the situation.

I will give you data first from the American land forces, which comes from the office of the Surgeon General, Medical Statistics Division, dated 25 August 1947. This is the latest word that I could get. It is the relation of battle deaths to non-battle deaths. Let us go back to the Mexican War first. You remember, that lasted from April 1846, to February 1848, back some little time. We find there a fairly sad situation. Twelve percent of the casualties died due to battle-received injuries, whereas 88 percent died due to diseases that had nothing to do with the battle except that a group of men were living closer together than they would have been, had they been at home.

The Civil War gave us practically the same sort of thing. Thirty-two percent on the Northern side and 36 percent on the Southern side died due to battle injuries, and 68 and 63 percent respectively due to diseases. When you get to the Spanish-American War you really see something. Only 7 percent of the people who went down there and died were killed by virtue of having anything to do with the war, whereas 93 percent died from disease. That is a pretty sad situation. The Philippine Insurrection was not so long ago—in 1899 to 1902. I know there are some people here who

were born before then, because I was and I don't think I am any older than you are. The situation there was again 15 percent due to battle injuries and 85 percent of deaths due to diseases that were contracted by the people who went into that area. So far the medicos have fallen flat on their faces. They haven't shown any progress at all.

Take World War I---the situation looks a little better. There were 51,259 died due to battle injuries and 55,868 died due to diseases not related to battle injuries, in other words, a ratio of 47.5 to 52.5 percent. But when we really came into our own was the late war. Seventy-seven percent of the casualties died due to battle, that is, 237,049. These are Army studies, and they do not include the Navy and Marine Corps. Only 23 percent were dead due to non-battle injuries, in other words, due to diseases of one kind or another. I think that is a definite indication of progress.

You might have some interest in this connection in some Navy and Marine Corps statistics along this very same line. It is interesting to note that the proportion of people killed outright to those wounded in the late war was tremendously higher than in any other war. Thirty-six percent were killed outright as related to those wounded so far as the Navy was concerned in the late war, whereas only 16 percent in World War I were killed outright with relation to those wounded.

The treatment of the wounded in World War II was absolutely unbelievable. I don't know what extreme adjective you might use. It certainly is amazing. These statistics hold within a matter of very minor variations for the Army as well as the Navy. These happen to be Navy statistics. Ninety-seven out of every 100 wounded got well. Some people have said that some men were so horribly mangled that they should not have been allowed to live, but we understood it to be the medico's job to keep them alive if possible. We did a magnificent job when we realize that less than 3 percent of the wounded in this war died, whereas 11.1 percent died in World War I.

This record was not accomplished by any one thing. To give you an idea of the progress let me say that many of these innovations occurred just during World War II. One of them was the sulfanilamide drugs in all their various forms. Another was penicillin. Since that we have had other things come along. There was the blood plasma. Everywhere there was blood plasma. That was our number one life saver. Everywhere whole blood was flown, even to the Pacific beach areas. There was nothing in the past like the immediate first aid care in this war. As a matter of fact, it was so effectively rendered that the casualty rate among the first aid men in the Marines was higher than it was among the actual combat troops. That was probably true also in the Army and Navy. So they were right in there pitching; there is no question about that.

The Medical Corps brought in doctors and set up beachhead hospitals. Hospitals were built on all sorts of fast-moving ships. They relayed the wounded right out to hospital ships. They flew them out wherever possible. All these things done on the beaches by the Army and Navy and Marine Corps brought about this remarkable situation so far as the wounded are concerned.

The Navy showed a similar improvement in the treatment of diseases to that shown by the Army in this war. A few examples of specific nature rather than general statistics may serve to highlight this point.

In World War I one of every three cases of meningitis died, while in World War II only one in 22 cases was lost. Nearly 12 percent of lobar pneumonia patients died in World War I, while less than one percent succumbed in the recent war. That is a very nice percentage of decrease——from 12 to 1. Similarly the fatality rate for scarlet fever was reduced from 10 deaths per 1,000 cases to less than 1; measles from 8 per 1,000 cases to 0.4 and erysipelas from 20 to 0.7. These figures are indicative of the way in which deaths from various diseases were reduced by improved treatment methods.

In preventive medicine both forces were very active, of course. It is clearly better to prevent a disease than it is to cure it after it occurs. This applies, of course, to maintaining the effectiveness of your manpower. It is better to keep them well than to have to treat them even though your treatment may be very effective.

They applied all known methods, of course. Immunizing inoculations were used effectively in the control of smallpox, typhoid fever, tetanus, cholera, yellow fever, and other serious diseases. Prophylactic medications were used in combating malaria, dysentery, and other maladies.

The high standards of sanitation were really gratifying. We went into Japanese pest holes, where normally people would have died like the proverbial rats, and actually they were cleaned up overnight to the extent that the situation there was better than it was in the United States.

As a matter of fact, the over-all reduction in disease is reflected by the admission rates for diseases. In World War I the annual rate per thousand strength was 635, while in the late war the rate was only 398 per thousand or 37 percent lower.

Other interesting statistics in this connection are that not only was the admission rate lower in World War II than in the previous war, but so far as the Navy is concerned it was lower than for any year from 1900 to 1934. The disease and death rate was lower in the Navy during

the worst war year than it was during peacetime. In fact, one of the war years yielded a disease admission rate that was the second lowest of any year of peace or war in this century.

If we plot the actual national longevity rate and the national death rate, which, of course, are the same thing, you can't find a single difference during the war. It just didn't change. It flowed right along. So actually we were practically as well off during the war as a nation from the standpoint of health and longevity. We certainly got away from killing people on the highways. That sort of thing was practically stopped during the war. Now we have stepped it up so that the death rate is up. I presume that must be the reason.

Let me give you a picture of one of the unsolved problems. This will show you how a medical war is fought. I wouldn't expect you to believe these statistics, except that they come from both the Army and Navy and hence are from such very reliable sources that we must accept them.

I want to talk for just a moment about the situation with respect to malaria. These are preliminary data. People in the Surgeon General's Office said they didn't want me to quote them that this is absolutely right, but they say this is as close as they can get. Later they will have the absolute figures. The total man-days lost from malaria alone for 1942 to 1945, inclusive, were 9 million. Just think of that. You actually had 9 million man-days lost during the late war from malaria. That is really a startling thing to think of. Of course there were 66 million man-days lost due to battle casualties, but you expect them. You don't expect to see 9 million due to malaria. In the Southwest Pacific half of all the admissions for everything were due to malaria. In the Navy malaria was thirteenth as a cause of death, seventh in occurrence, and third as a cause of days lost. The only things ahead of malaria were fractures and "cat fever". The diagnosis of "cat fever" covers everything like a cold to a little temperature. Fractures of the arm or leg were of very high incidence. Of course, they stayed in the hospital a long time while the thing was being allowed to knit. So the only two things ahead of malaria were those two.

Another interesting statistic in connection with malaria is that during the war years the Office of Scientific Research and Development spent five and half million dollars trying to lick the malaria problem. That is a lot of money to spend on one disease, and still they did not come up with any final definitive answer.

The situation is bad now, but if we go back and read history, which I am not going to take time to do now, we find that it was much worse both in the Civil War and in World War I. At times whole armies were immobilized by malaria. One of the French generals in World War I was supposed to attack a certain area at a certain time. He wrote back, "Impossible to attack. Army in hospital with malaria." Actually 85 percent of them were, so he had nothing left to attack with. So it can be a very, very crippling force.

Now, why haven't we licked malaria? There are a lot of answers. I will try to give you some idea how these problems stack up as we start to plan ahead how we are going to implement the improvement that is necessary if we are going to keep as many men healthy as many hours as possible. And that is the function of the medical group.

Well, in the case of malaria the treatment is adequate but not specific. It is not like some things where you do a specific thing and that is that. The prophylaxis is not specific and perhaps not adequate, at least not without a certain number of side effects. Protection from the bite of the mosquito is difficult. Men won't wear the nets very often. Even when they do put the nets on, the net will get against their face and the mosquitoes will bite through it. Eradication of mosquitoes is difficult and expensive. It takes oil. It takes all sorts of activities. It just doesn't seem to get done when the pressure of time for fighting the war is on. Another thing is the problem of training and educating all hands, both the people administering the program and the people who are supposed to cooperate in it. So the problems in such a thing as malaria are manifold. Our hope in this field, as in all others, lies in these people who are doing research.

By the way, application is just as important as research. Sometimes wonderful discoveries are blocked completely because some people higher up say, "Hugh, I don't believe it. It was all right when I was a youngster to do it this way. We won't change." I am sure your group will not think that way, because you are at a higher echelon so far as research and development are concerned than some of your line brethren who have never learned to think in an advanced way. But that sort of thing is important. We must apply what we know as well as work on the research angle of it.

Now let us turn for just a moment to how we are going to maintain our human resources at their most efficient level by the utilization of manpower. I trust that I will not go far afield here. I am very much sold on this idea and perhaps will be considered to be radical. But I am certain that much can be done by proper instruction and placement of individuals in the type of jobs that they are most properly fitted to do.

We have neglected that rather steadily both within the services and in the country as a whole. We are just beginning to wake up to it now.

Of course, the one thing in selection which is most important is your physical selection. You all went through physical examinations. Some of them were important. But on the other hand I think that we have probably taken that part of it a little too seriously. We are sort of like the Prussian Guards, where everyone has to be exactly the same height, the same color of eyes, and everything. We should not be interested so much in an individual's looks as in his health and his likelihood to stay healthy.

Of course we are interested in the special senses like vision and hearing. That is definitely a medical problem. There is no question about that. What do we want for the Army? If an individual is hospitalized for a disability of some kind, unless it is very carefully handled, he may say that the war service has caused an increase in his symptoms, and that therefore he is entitled to compensation. So it is the professional duty of the medicos to be as careful with that as possible.

I am certain that if another war comes around, we will have to take up the idea that we can use more individuals who are physically defective in various ways within the structure of the military. There is no reason why a man who has lost his usefulness in one military service should not be useful for further service just because he has some minor disability. I think we will have to handle this problem more carefully in the future.

Now, taking up the field of vision, a man's vision is important in the Navy, where men have to be lookouts, range finders, and radar operators, telescope readers, instrument readers, and such. The number of these men continues to increase as warfare gets more technical. We are also interested in hearing as it relates to sound detection. There are so many things that depend on sound, and there are going to be more of them.

We are interested in simple things like speech defects. I don't know how many of you have heard the story of the young officer who was docking a submarine. He stuttered. In his excitement--he was going ahead at a pretty good clip--he wanted to say "Back her down", but all he could say was, "B-B-B" and by the time he got the "back" out he hit the cement piling. So we can't take a stutterer. These things must be considered as part of the problem of physical selection.

Then on the psychometric selection, you remember the intelligence tests. All of you have had intelligence tests. They have now become a matter accepted as part of the routine of getting into any of the military services. One thing that we sometimes forget in relation to intelligence

tests is that they can be used not only as a method of saying "This man is out and this man is in," but they can be used and should be used in connection with the problem of training, because you can indicate a group of people who are passable but pretty low in intelligence, that in training will need additional supervision and help. That is a very important thing to know. And in that connection your selection people should work with the training people.

In this war we made a very brave attempt at psychological testing and made some progress. I won't go along with some of the people who say it is a finished art, but I will say we have made some progress in it.

The personality make-up of an individual has definite importance. I know it was important in the submarine service, because when you toss seven officers and seventy men together and lock them up and say," You are going to have to live there together for two months," we want to make sure there are not too many people in there who are going to completely disrupt the organization.

Now, how are you going to find out that this man has emotional maturity and emotional stability or whether he is a trouble maker, whether he is a psycopath, as we call such? You can do that either by the so-called paper and pencil test, in which you have the individual answer a series of direct questions by yes or no answers, or by forced choices of one kind or another; or you can do it with an interview. At any rate it is a method you use to try to find out something about that individual's background. You find out something about his parents. That has a bearing. Parentage is certainly important. You want to be careful what kind of parents you have.

Your home life is certainly important. It makes a definite difference what sort of home you live in. Your childhood as you grew up is important, whether you were happy or unhappy; your schooling; how well you adjusted to school life, how much truancy there was, how you got along with the teachers. All those things have an important aspect. Your work, whether you change from job to job and from city to city. All those things come into the picture. Your social adjustment, your social activities, your emotional stability and emotional maturity. There are many questions given here to find out whether or not you are adult in every sense of the word. Your sexual drive is an important aspect certainly, though not the entire picture, as some would try to make you believe. Your moral and religious beliefs and convictions are very important. I would like to illustrate these points but my time is slipping away and I don't think I have time to do it. Your interests and hobbies are important.

Now, as I say, you can accomplish this either by the pencil and paper test or by an interview or by both of them. The pencil and paper test was used as a rough screen. You first give the paper and pencil test and then send him to an interviewer, who goes into various phases that are indicated by the paper and pencil test which he has just taken.

The psychiatrists did quite à good job in this war. It is quite enlightening to realize that twice as many men, both at the induction level and later, were invalided from the service for psychiatric disabilities than for any other combination of half a dozen things. So if individuals were not well adjusted, the psychiatrist was supposed to rule them out, to rule out these mal-adjusted people, the trouble-makers, those who were psychopaths, who were in some cases outright psychotic— actually crazy.

The psychiatrist should work hand in hand with the men doing the paper and pencil testing. That way we actually achieve something, because we get at the roots of the trouble. That is sometimes hard to accomplish, because psychiatrists think they are a group distinctly set apart by God and won't associate with anyone else. We must lick that idea, so we can all work together. We will get a much better product that way.

All of this is doubly important when you think of the possibility, perhaps even the probability, of having a large increase due to compulsory military training. We certainly must do something about finding out what these individuals will be able to do for us in case of another war. We must have something in the way of selection that we can go to.

As a matter of fact, there are individuals—I won't mention names—who believe we should not have compulsory military training, but should concentrate our activities upon the problem of properly evaluating and classifying and selecting, if you will, individuals at a given age level in this country, so we will know what we have to draw from; that we should spend our money and our time working in that field rather than bringing those people in for a period of training. I will not try to speak on that, but at least there is a possibility in that field that is worth thinking about.

Again, additional and continuing research in that field is imperative. It is interesting to note that we have several projects in our organization dealing in conference effectiveness. Practically all decisions made not only within the Services but outside the Services are made at the conference level. And yet how many of us realize what you have to do to make a conference function, how much planning ahead of time goes into it, how many people you have to line up who can think and talk on

your side, and so forth and so on. That whole question should be looked into very carefully. How effective is a conference? Is a conference really the democratic way of doing it, or is it simply a democratic way of being autocratic, if you know what I mean?

We are interested, of course, in leadership selection. Also we are interested in whether or not leadership emerges in a group. I wish I had time to tell you about some of the experiments that were performed last summer on the emergence of leadership. It would take more time than I have. But at least we are thinking along these lines. They are very important lines when it comes to the broader aspects of medical research.

One topic I was asked to talk about is the current trends in medical research—what the prospects are and what we are going after. I think everyone who has studied the field of research in its broader aspects will admit that the major and most significant trend is the cooperative working together of the different disciplines of science, the different scientific groups. Perhaps I can illustrate it by several different quick examples.

Take biochemistry. In the old days it was the biologist and the chemist. Now we have gone so far that it is one man, the biochemist. He takes care of both of these fields himself. Bacteriology has now become micro-biology, because it includes so much. When I went to school and studied bacteriology it was quite a different situation. The study of environmental biology involves the biologist, the physiologist, and the medical geographer. By the way, I didn't realize until recently that there were so many kinds of geographers. I thought they were all people who draw maps. But there are all sorts and they are a very important group of people.

The environmental biologist works with the meterologist. He tells us something about what you can expect in various parts of the world, how to prepare your defense against the elements. Environmental biology has now come to be a study that is at the roots of this more or less. At least it is a definite problem that we are cooperatively working on. Everybody is working together in these things, not just as medicos, not just meterologists, not just geographers, but all working together.

Another advance that I think definitely indicates this thesis I am developing, this cooperative trend in medicine at the present time, is biophysics. You think immediately of the problems of the nuclear physicists, of radioactive isotopes used in the fields of medicine. See what that is doing in the field of medicine. It is positively revolutionizing the services. You realize now that you can take an element and follow it into any organ or any tissue. You can know what happens in the body metabolism, whereas heretofore you had to go to the laboratory

and try to find out. You can know the biochemistry, you can know the physiology, you can know all the way through, by using radioactive isotopes as tracers.

In the treatment field you have, of course, an amazing story. One scientist who is too well known and too reputable to have said what he said the other day over the radio indicated that the treatment of cancer is now assured by the use of radioactive isotopes. He should not have said that. I could tell him two types of cancer where we have had good luck with the use of radioactive isotopes, but that is only two types. And there are failures in them. There is a gleam of hope, but that is all.

So again I say, the medicos must work together with all these other fields. If you want to set up a medical experiment now, you must either have an electrical engineer at your side or you must be one. In any combination of medical research you must either have a physicist at your side or be one. Our cooperative endeavor must be together. I believe this cooperation between the various disciplines of science is going to be one of the greatest hopes in the future for medical research. There is no question but that it is tremendously important.

In this field, of course, there is the whole science of human engineering. I could spend the entire period of time assigned to this lecture in just the field of human engineering. I am not sure how good this word is. We have argued and discussed new words for it. I won't tell you what all of them are. A lot of them have fancy Greek derivatives. But at least we get an idea of what human engineering is.

Unfortunately, God made the human being more or less as is, and there isn't too much you can do to change his structure or change his strength or change his responses. You can do little through education to get higher intelligence or a better heart or vision.

What are the human engineers doing? They are finding out everything they can possibly find out about the normal individual. That seems like a pretty simple proposition, but it isn't. It is tremendously complex.

The first, and of course, the simplest part of it, is just the measurements of the body. What size head do we have to fit helmets to? What size faces do we have to fit masks to? Even that is not too easy. There are some of the queerest shapes that you can think of. Take just the problem of ear plugs. A tremendous amount of work has been done to see how effective those were that we had. The Navy--and I am sure this was true of the Army Medical Corps--was just in the process of ordering several million ear plugs when suddenly I got a call, "What sizes do you want of these things?" I said to my assistant, "Nobody ever thought of that."

So we immediately got a group of people together and they worked out the sizes in a few days. It was a very interesting thing. We were able to say how many small, medium, and large we would probably need, and we got it right within seven percent. Some of the population have entirely different ear canals on one side of the head than on the other, so you have to make some mixed pairs for some of the people.

We are interested in arm reach also. I heard a lecture yesterday which went on for thirty minutes dealing with the problem of reach as related to the placement of instruments within the cockpit of an airplane. How can you measure what the reach is? It sounds simple. You just reach out and measure it. But remember, the shoulder is a very movable thing and you can reach further in one plane than another. They have worked out a technique for determining reach as one method of finding out whether a pilot can work within certain types of planes.

Strength measurements, of course, are important. How much can you put in the way of strength in your fist? How much can you flex? How much can you pull? How much can you thrust? If you have your leg on a pedal, what way is the best way of giving thrust to it--with the leg in flexion or extended and pushing against it in that way?

The proposition of resistance to stress is another problem. How much can you take? How many g's can you take of acceleration? How many g's of deceleration? An argument is going on among our scientific brethren as to what will happen when one of these super-super jets fails in a supersonic area. Really, it is amazing. That seems to be one of the final problems on sonic operation. You get up into these supersonic flights and, if the plane fails, the amount of deceleration will be so terrific that no human being can live, no matter what system you fix of strapping in. I mean, the deceleration is going to be so terrific that the pilot will die. That must be worked out. It is a medical problem of great interest. If you are in a plane, it is particularly interesting.

Adjustment to environmental changes is another thing. We have to work that out so far as human beings are concerned. What can you stand in the way of a deprivation of the oxygen supply? What can you stand in atmospheric pressure changes? We have done a lot of work in that field. We still don't have any definitive answers.

What can we do with temperature changes? I have fresh in mind a story specifically with regard to that. We are trying to find out the effects of temperature changes. You can't subject human beings to temperature changes like you can animals. So we had an agricultural outfit down in Oklahoma where they were using horses and mules and asses for putting in high temperatures. They used them because they are sweating animals. You could work them hard and see what the reaction was.

The budgetary request was made up by biochemists and physiologists, and when the proposal was being finally sent through, it listed sweating asses as one of the experimental animals. The admiral in charge looked at the proposal and said, "What are people going to think when they see in here 'experiments on sweating asses'?" But at least we are thinking in the field of high temperatures.

We are interested, of course, in applying this knowledge that we get to normal individuals, applying it to the engineering that is going on. It certainly should be applied. We are not doing that now. We build gadgets and then find out later that no human being can possibly handle them. Now we are engineering things where the human being doesn't have to have six sets of eyes, four arms, and five legs. But they are still building gadgets that no one person can handle. So we must become rational in our thinking. The location of dials, the size, lighting, color, the excursion of levers, the type of handle, the direction of movement, and so forth. What can you do this way as compared with what you can do that way? There are visual findings as applied to the construction of range finders, optical equipment, radar, scopes, and so forth. We have a lot of work that has to be done in those fields. There are the auditory findings as applied to sonar detecting equipment.

Psychological problems are very important as related to these constructions. I think I will take a moment to tell you just one story relating to psychological problems. We had some sound gear located so the individual had to sit pointing to the side of the ship. All of you flying officers here know that when you are gunning the ship you think forward. You always think forward. If you are listening to something and suddenly have to translate it at a 90-degree angle, you are in trouble. The sound man simply couldn't adjust his orientation. So it was much simpler to design that so as to change the sound gear in this postion. Psychological problems like that are very numerous.

I should not take all my horrible examples from the Navy. I should be able to think of some from the Army. But I am more familiar with the Navy's, I will have to admit. You probably have a few horrible examples too that I could dig up if I looked for them.

The medical men and the engineers have simply got to work together. That is one of the things in which we can get real advance.

I would like to tell something for just half a moment about the Armed Forces NRC Division. That has to do with the problem of panel thinking. Usually your panels are vertical. Everybody in one particular arm is in that panel. So they all think the same way and they act only in one narrow plane. But if you could construct your panels and your committees horizontally, you might get somewhere.

When you think of vision people, most of you think of your eyes being tested. You perhaps have pinkeye and you go to a doctor. But actually vision involves a tremendous amount more than that. Just let me think for a moment with you. You must have someone who knows the physiology of the eye, what it will do, what it can stand, what happens in the Arctic, what happens in the glare from the tropical sun. You must have an individual who knows the eye diseases, about examining the eye. You must have a psychologist who knows how to construct tests, to administer tests, and rate tests for mass selection work. You have to have certainly a man who knows more about optics than anybody else, because the human eye must be related to optics. We went through a violent battle on the periscope on that. They wanted to make something as a submarine periscope that the human eye could not use. You can't change the optics of the eye. You must have the two working together there.

Certainly it makes a difference what the atmosphere is between here and over there. So you have to have a man who knows something about atmosphere. You have to have a man who knows about colored lights and how they affect the eye, who knows about lighting, and so forth. I could go on ad nauseam. But unless you have a group organized along that line when you go to attack any particular problem, you won't get anywhere.

Another field of tremendous importance that I will just mention is this: We are composed of a great many individual cells. In the individual cell is the primary change that leads to either abnormal growth, that is, cancer, or normal growth. We call that cell degeneration. We don't think of it as related to heart disease, liver disease, and so forth. There are tremendous possibilities for research on the individual cells through the use of radioactive isotopes, which you can use as tracer elements.

Let me talk for just a moment about what facilities are available. I am not going to discuss them. I am just going to mention them.

The first is personnel. The first type of personnel is the Ph.D's in the medical sciences, in anatomy, bacteriology, biochemistry, entomology, genetics, medicine and surgery, pharmacology, physiology, public health, and zoology. That group in the so-called medical allied sciences graduated from 1936 to 1945, inclusive, 4,227 of these brethren or about 422 per year. Assuming that for the ten years before that there were at least 400 a year and that the majority of them are still alive, you have 8,000 people in that field that we can draw upon. There are some older than that, but they are probably too fuddy duddy to carry on in the present young man's war. There was a large number of PhD's in

psychology. They definitely should be able to help in this field. The M.D.'s provided about 5,000 a year. But very few of them stay in research. Most of them go out and try to make a lot of money.

There is another approach to this that I think is interesting. I have a chart here showing the number of people in the biological sciences as taken from the American Association for the Advancement of Science. They have in the biological sciences, the ones we are talking about, 13,492 and in the physical sciences—we are not interested in them so much—14,961.

Now, suppose that three thousand of these people are potential investigators. I have just tossed those ten thousand out as not being capable of handling investigation in research for us. Suppose, which seems to be a reasonable assumption—some say a little lower and some a little higher—that it costs 25,000 dollars to activate one research director with his assistants, with his secretarial help, technical help, animals, equipment, and so forth—this is not a bad figure—we could spend 75 million dollars a year on just research and have only one project for each of these three thousand men. That doesn't include the M.D.'s. So when you think about where the money is coming from, just bear in mind that you can spend a pile of money on only one project for each of the three thousand, when there are that many(indicating) possible investigators that could be actively working. That is another way of approaching the general problem of personnel as it relates to this whole field.

Now, what do we have in the way of funds? Well, 110 million dollars were available from all sources in 1947 for medical research. The percent distribution was: from industry 45; Federal, State, and local governments 28; foundations 13; voluntary associations 9; all other sources, 5 percent.

The estimated Federal expenditures—Army, Navy, Veterans, and so forth, the whole group—were 28,150,000 dollars. The major sources of private expenditures for medical research in 1947 were industry, exclusive of industrial foundations, 50 million; philanthropic foundations, 10 million; industrial foundations, 5 million; and voluntary associations, 10 million, or a total of 75 million dollars from all sources.

As to local research facilities, we will take a look at one of these charts. There are plenty of local facilities. Let us look at these colleges. This is corrected to give only the big ones, only the ones that can actually help in this work. There are 360 such colleges that could actually implement research in the medical and biological sciences. They have four departments—the Department of Psychology,

the Department of Biology, and so forth, that could take projects. We have 1,440 different departments. Of medical schools there are 80. These have 28 different departments. In other words, every department in a medical school could take one project. That would mean 2,240 departments. There are 60 pharmacy schools. They could take perhaps two projects in each pharmacy school That is 120 different departments. As to the agricultural schools, we can get at least three projects out of each one of those. They are taking some work, not only so far as animals are concerned, but so far as man is concerned. There are 180 departments there. The dental schools, two in each of 40, or 80 departments. Hospitals approved by the AMA—these are the really big ones, not the little facilities—800 hospitals, times one, 800. Only one project in each hospital.

That makes 4,860 facilities. Say it costs 25,000 dollars for each, you could spend 126.5 million dollars in medical research and put only one project in each one of these departments, which certainly is not emphasizing the proposition too much. So much for the facilities available.

As to the national and major philanthropic foundations interested in medical research, we can simply read that list and not discuss them. I would like to read them so you will realize how many there are. There are a lot more than I thought there were, and I thought I was fairly well informed in this field. There are a lot that are interested in physical research, but these are only the ones interested in medical research. National Foundation for Infantile Paralysis, National Tuberculosis Association, National Cancer Foundation, Red Cross—largely not in medical research, but in some areas they are in it—Rockefeller Foundation, Markle Foundation, the Macey Foundation, Kellog Foundation, Milbank Foundation, American Foundation for High Blood Pressure, Baruch Foundation for Physical Medicine, Life Insurance Medical Research Fund, Nutrition Foundation, Sugar Research Foundation, and National Vitamin Foundation.

That does not include any of the government agencies. This is a list of the government agencies: these were taken from press reports and from the Steelman Report. My listing is in the order they gave. The Agriculture Department has the Bureau of Animal Industry, the Bureau of Dairy Industry, the Bureau of Entomology and Plant Quarantine, and the Bureau of Human Nutrition and Home Economics. The Commerce Department has the National Bureau of Standards and the Weather Bureau. Both of those have been used extensively for medical work. The Department of the Interior has the Bureau of Mines and the Fish and Wildlife Service. The Federal Security Agency has the United States Public Health Service and its National Institute

of Health and National Cancer Institute. The Federal Security Agency has also St. Elizabeths Hospital and the Food and Drug Administration. The Department of the Navy has the Office of Naval Research, with nine divisions, which I will not attempt to enumerate. All of them are in active medical research. The Department of the Army has the Technical Services: The Chemical Corps, with its Edgewood Arsenal and Camp Detrick—work is being done at both those places; the Medical Department has the Army Medical Center, the Army Industrial Hygiene Laboratory, the Army Institute of Pathology, the Medical Department Field Research Laboratory, the Medical Nutrition Laboratory, and the Veterinary Research Laboratory; the Quartermaster Corps has the Climatic Research Laboratory and the Quartermaster Food and Container Institute for the Armed Forces. The Smithsonian Institution has its Research Divisions. The Atomic Energy Commission has a Research Division and a Medical Advisory Board. The Veterans' Administration has its Medical Research Division. The U.S. Air Force has various research units and fields. I am not going to mention them all. There are Wright Field, Patterson Field, and so forth. We are trying to do a tremendous amount of medical research.

Now, I had better not show these slides, because my time is about gone. I was going to show you some examples of our program at the Office of Naval Research.

The only thing I do want to mention before I close is the coordinating and advisory agencies. How is all this mass of research done in all these different places going to be coordinated? Well, I was going to say "God only knows" because I don't think it is going to be done. But at least there is going to be some attempt to coordinate it. One such agency is the National Academy of Sciences. Another is the National Research Council. Many government agencies and a number of private agencies go to them for advice; and, because so many go to them for advice, they have a reasonable idea of what others are doing. Their advice tends to help coordinate, although they are not a coordinating agency. The only possible coordinating agency is the Research and Development Board, formerly the Joint Research and Development Board. They will have representation from the three services and will have an equal number of high-type civilian scientists.

Now, they do have the power to coordinate; and they have the power, if they want to use it—they say they are not going to use it—of directing which organization shall do what type of research. That is only within the military; that is not within the federal agencies. They won't have anything to do with agencies like the Public Health Service, but only with the Army, Navy, and Air Force. As things are now, nobody is going to direct the rest of them.

There is no question indeed but what medical research is vital. It must be continued. It must be increased. It must be further implemented. It must be coordinated.

The nation that is ready so far as research is concerned is the one that is feared. I think there is no question that the only reason biological warfare was not used against us this time was that they knew we were ready. That is the way to stay in all of this medical research.

Without research no progress is possible. Progress is essential. Our strength lies not in volume of material, but in progress and in proper utilization of our human resources at the maximum of efficiency.

CAPTAIN ROWLEY: Are there any questions? (No response.)

Thank you very much, Captain Shilling, for your very informative talk.

(30 December 1947--450)S.

RESTRICTED